L Number	Hits	Search Text	DB	Time stamp
1	4036450	data storage\$1	USPAT;	2004/06/11 13:23
-		····	US-PGPUB;	=====================================
] .			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
2	16218	read adj write adj head\$!	USPAT;	2004/06/11 13:24
-	10210	read adj write adj ricadş:	US-PGPUB;	2004/00/11 13.24
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
3	7597355	media surface\$1	USPAT;	2004/06/11 13:24
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			EPO; JPO;	
			DERWENT;	İ
			IBM_TDB	
4	1153956	controller\$1	USPAT;	2004/06/11 12:25
	1133330	Condoners	US-PGPUB;	2004/06/11 13:25
			EPO; JPO;	
			DERWENT; IBM_TDB	
5	3459787	predetermined track density		2004/06/11 12:26
3	3433707	predetermined track density	USPAT;	2004/06/11 13:26
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
6	1953939	linear density	IBM_TDB	2004/06/11 12:26
١	1333333	illear density	USPAT;	2004/06/11 13:26
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
7	2734127	error code level near1 data	IBM_TDB	2004/06/11 12:26
'	2/3412/	error code lever riedi i data	USPAT;	2004/06/11 13:26
			US-PGPUB;	
			EPO; JPO;	
			DERWENT; IBM_TDB	
8	13619	(data storage\$1) and (read adj write adj head\$!)	. —	2004/06/11 12:27
8	13019	(data storages) and (read adj write adj rieads!)	USPAT;	2004/06/11 13:27
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
9	15839	(media surface\$1) and ((data storage\$1) and (read adj write adj	IBM_TDB	2004/06/11 12:20
	13039	head\$!))	USPAT;	2004/06/11 13:28
		ileauş://	US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
10	880	controller\$1 and ((media surface\$1) and ((data storage\$1) and	IBM_TDB	2004/06/11 12:20
10	000	(read adj write adj head\$!)))	USPAT;	2004/06/11 13:28
		(read adj write adj ricada:///	US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
11	6004033	(predetermined track density) or (linear density) or (error code	IBM_TDB USPAT;	2004/06/11 12:20
	000-033	(predetermined track density) or (linear density) or (error code   level near1 data)		2004/06/11 13:29
		icverneurz data)	US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
12	817	(controller\$1 and ((media surface\$1) and ((data storage\$1) and	IBM_TDB	2004/06/11 12:25
**	317	(read adj write adj head\$!)))) and ((predetermined track density)	USPAT;	2004/06/11 13:35
		or (linear density) or (error code level near1 data))	US-PGPUB;	
		(miser density) of terror code level heal I data)	EPO; JPO;	
			DERWENT;	
L			IBM_TDB	

13	2782885	maximum recordable track density	USPAT;	2004/06/11 13:36
	1		US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
14	2965427	maximum recordable linear density	USPAT;	2004/06/11 13:39
		·	US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
15	3326757	(maximum recordable track density) or (maximum recordable	USPAT;	2004/06/11 13:39
	33_37	linear density)	US-PGPUB;	200 1/00/11 13.33
		mical delicity)	EPO; JPO;	
			DERWENT;	
			IBM_TDB	
16	3944362	minimum recordable error code level near1 data		2004/06/11 12:40
10	3944302	minimum recordable error code level hear1 data	USPAT;	2004/06/11 13:40
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
17	F004355	Managing we as added to be a first of the collection of the collec	IBM_TDB	0004/04/44
17	5991264	((maximum recordable track density) or (maximum recordable	USPAT;	2004/06/11 13:40
		linear density)) or (minimum recordable error code level near1	US-PGPUB;	
		data)	EPO; JPO;	
			DERWENT;	
			IBM_TDB	
18	749	((controller\$1 and ((media surface\$1) and ((data storage\$1) and	USPAT;	2004/06/11 13:47
		(read adj write adj head\$!)))) and ((predetermined track density)	US-PGPUB;	
		or (linear density) or (error code level near1 data))) and	EPO; JPO;	
		(((maximum recordable track density) or (maximum recordable	DERWENT;	
		linear density)) or (minimum recordable error code level near1	IBM_TDB	
		data))	· · <b>_ · · - ·</b>	
19	2554817	magnetic head	USPAT;	2004/06/11 13:47
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
20	7278716	magnetic surface	USPAT;	2004/06/11 13:47
120	72,0,10	magnetic surface	US-PGPUB;	2004/00/11 13.47
-				
			EPO; JPO;	
			DERWENT;	
21	1072105	(magnetic head) and (magnetic surface)	IBM_TDB	2004/05/44 15 15
21	1873105	(magnetic head) and (magnetic surface)	USPAT;	2004/06/11 13:48
	1		US-PGPUB;	
1	1		EPO; JPO;	
	1		DERWENT;	
1 22		///	IBM_TDB	
22	210	(((controller\$1 and ((media surface\$1) and ((data storage\$1) and	USPAT;	2004/06/11 13:51
		(read adj write adj head\$!)))) and ((predetermined track density)	US-PGPUB;	
		or (linear density) or (error code level near1 data))) and	EPO; JPO;	
		(((maximum recordable track density) or (maximum recordable	DERWENT;	
		linear density)) or (minimum recordable error code level near1	IBM_TDB	
		data))) and ((magnetic head) and (magnetic surface))	_	
23	364382	compar\$3 and (quality metric with reference metric)	USPAT;	2004/06/11 13:54
		•	US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
24	75	((((controller\$1 and ((media surface\$1) and ((data storage\$1) and	USPAT;	2004/06/11 13:56
- '		(read adj write adj head\$!)))) and ((predetermined track density)	US-PGPUB;	200 1/00/11 15.50
		or (linear density) or (error code level near1 data))) and	EPO; JPO;	
		(((maximum recordable track density) or (maximum recordable	DERWENT;	
		linear density)) or (minimum recordable error code level near1	IBM_TDB	
		data))) and ((magnetic head) and (magnetic surface))) and	םטו_ויוטג	
		(compar\$3 and (quality metric with reference metric))		
·	1	(Comparas and (quality metric with reference metric))		L

25	2859107	acceptable error rate\$1	USPAT;	2004/06/11 13:56
25	2039107	acceptable error rates 1	US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/00/11 15.56
26	70	(((((controller\$1 and ((media surface\$1) and ((data storage\$1) and (read adj write adj head\$!)))) and ((predetermined track density) or (linear density) or (error code level near1 data))) and (((maximum recordable track density) or (maximum recordable linear density)) or (minimum recordable error code level near1 data))) and ((magnetic head) and (magnetic surface))) and (compar\$3 and (quality metric with reference metric))) and (acceptable error rate\$1)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/06/11 13:56
27	324749	measur\$3 with (((predetermined track density) or (linear density) or (error code level near1 data)))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/06/11 13:59
28	15	((((((controller\$1 and ((media surface\$1) and ((data storage\$1) and (read adj write adj head\$!)))) and ((predetermined track density) or (linear density) or (error code level near1 data))) and (((maximum recordable track density) or (maximum recordable linear density)) or (minimum recordable error code level near1 data))) and ((magnetic head) and (magnetic surface))) and (compar\$3 and (quality metric with reference metric))) and (acceptable error rate\$1)) and (measur\$3 with (((predetermined track density) or (linear density) or (error code level near1 data))))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/06/11 13:59
29	148307	program\$4 and (write data with (measur\$3 with (((predetermined track density) or (linear density) or (error code level near1 data)))))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/06/11 14:00
30	4	((((((((controller\$1 and ((media surface\$1) and ((data storage\$1) and (read adj write adj head\$!)))) and ((predetermined track density) or (linear density) or (error code level near1 data))) and (((maximum recordable track density) or (maximum recordable linear density)) or (minimum recordable error code level near1 data))) and ((magnetic head) and (magnetic surface))) and (compar\$3 and (quality metric with reference metric))) and (acceptable error rate\$1)) and (measur\$3 with (((predetermined track density) or (linear density) or (error code level near1 data))))) and (program\$4 and (write data with (measur\$3 with (((predetermined track density) or (linear density) or (error code level near1 data))))))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/06/11 14:02
31	11356	714/774.ccls. or 714/?.ccls. or 360/?.ccls. or 369/?.ccls. or 365/?.ccls. or 386/?.ccls.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/06/11 14:04



# (12) United States Patent Woodfill et al.

(10) Patent No.:

US 6,215,898 B1

(45) Date of Patent:

Apr. 10, 2001

## (54) DATA PROCESSING SYSTEM AND METHOD

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Carson City, NV (US); Robert Dale Alkire, San Jose, CA (US)

(73) Assignee: Interval Research Corporation, Palo

Alto, CA (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35

U.S.C. 154(b) by 0 days.

(21) Appl. No.: 08/839,767

(22) Filed: Apr. 15, 1997

382/303, 304; 348/42, 43, 46, 47; 336/12; 364/728.03, 728.05

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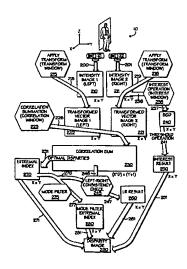
(List continued on next page.)

Primary Examiner—Scott Rogers (74) Attorney, Agent, or Firm—Ritter, VanPelt & Yi LLP

(57) ABSTRACT

A powerful, scaleable, and reconfigurable image processing system and method of processing data therein is described. This general purpose, reconfigurable engine with toroidal topology, distributed memory, and wide bandwidth I/O are capable of solving real applications at real-time speeds. The reconfigurable image processing system can be optimized to efficiently perform specialized computations, such as realtime video and audio processing. This reconfigurable image processing system provides high performance via high computational density, high memory bandwidth, and high I/O bandwidth. Generally, the reconfigurable image processing system and its control structure include a homogeneous array of 16 field programmable gate arrays (FPGA) and 16 static random access memories (SRAM) arranged in a partial torus configuration. The reconfigurable image processing system also includes a PCI bus interface chip, a clock control chip, and a datapath chip. It can be implemented in a single board. It receives data from its external environment, computes correspondence, and uses the results of the correspondence computations for various postprocessing industrial applications. The reconfigurable image processing system determines correspondence by using nonparametric local transforms followed by correlation. These non-parametric local transforms include the census and rank transforms. Other embodiments involve a combination of correspondence, rectification, a left-right consistency check, and the application of an interest operator.

## 40 Claims, 153 Drawing Sheets



L Number	Hits	Search Text	DB	Time stamp
1	1019544	electrically erasing data near1 block adj block	USPAT;	2004/06/11 19:30
			US-PGPUB;	
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1			DERWENT;	
			IBM_TDB	
2	1258691	electrically writing data near1 unit adj unit	USPAT;	2004/06/11 19:30
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
3	986131	(electrically erasing data near1 block adj block) and (electrically	USPAT;	2004/06/11 19:30
		writing data near1 unit adj unit)	US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
4	1498489	nonvolatile memory	USPAT;	2004/06/11 19:31
			US-PGPUB;	
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			DERWENT;	
			IBM_TDB	
5	164557	((electrically erasing data near1 block adj block) and (electrically	USPAT;	2004/06/11 19:32
	i i	writing data near1 unit adj unit)) and (nonvolatile memory)	US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
6	3870834	single semiconductor chip	USPAT;	2004/06/11 19:32
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			DERWENT;	
			IBM_TDB	
7	130778		USPAT;	2004/06/11 19:33
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	}	(single semiconductor chip)	EPO; JPO;	
			DERWENT;	
			IBM_TDB	
8	4713681	electrical signal\$1	USPAT;	2004/06/11 19:34
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			EPO; JPO;	
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_			IBM_TDB	
9	114438	((((electrically erasing data near1 block adj block) and (electrically	USPAT;	2004/06/11 19:35
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			DERWENT;	
10	7000505	pignal puggasata	IBM_TDB	2004/06/44 40:35
10	7989695	signal process\$3	USPAT;	2004/06/11 19:36
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
11	112005	////oloctrically oracing data popul black and black and	IBM_TDB	2004/00/44 40:20
11	112085	(((((electrically erasing data near1 block adj block) and	USPAT;	2004/06/11 19:38
		(electrically writing data near1 unit adj unit)) and (nonvolatile	US-PGPUB;	
		memory)) and (single semiconductor chip)) and (electrical	EPO; JPO;	
		signal\$1)) and (signal process\$3)	DERWENT;	
12	122205	chocket2 and (data with assert as satisfies A	IBM_TDB	2004/05/44 40:40
12	122205	check\$3 and (data with error\$1 or reliability)	USPAT;	2004/06/11 19:40
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
	l		IBM_TDB	

12	12572	/////alashiasib, analas data assaul blast. 1911-15	LICEAT	2004/05/44 12 15
13	13573	((((((electrically erasing data near1 block adj block) and	USPAT;	2004/06/11 19:42
		(electrically writing data near1 unit adj unit)) and (nonvolatile	US-PGPUB;	
		memory)) and (single semiconductor chip)) and (electrical	EPO; JPO;	·
		signal\$1)) and (signal process\$3)) and (check\$3 and (data with	DERWENT;	
14	2354290	error\$1 or reliability)) rewrit\$3 data and erased block\$1	IBM_TDB	2004/06/11 10:42
17	2334290	Tewnitas data and Terased blockat	USPAT;	2004/06/11 19:43
			US-PGPUB;	
			EPO; JPO; DERWENT;	
			IBM_TDB	
15	12461	(((((((electrically erasing data near1 block adj block) and	USPAT;	2004/06/11 19:44
	12.02	(electrically writing data near1 unit adj unit)) and (nonvolatile	US-PGPUB;	2004/00/11 13.44
		memory)) and (single semiconductor chip)) and (electrical	EPO; JPO;	
		signal\$1)) and (signal process\$3)) and (check\$3 and (data with	DERWENT;	
		error\$1 or reliability))) and (rewrit\$3 data and erased block\$1)	IBM_TDB	
·16	3494049	prescribed area	USPAT;	2004/06/11 19:44
		p. 656. 1566 41.64	US-PGPUB;	2001/00/11 15.11
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
17	9894	((((((((electrically erasing data near1 block adj block) and	USPAT;	2004/06/11 19:44
		(electrically writing data near1 unit adj unit)) and (nonvolatile	US-PGPUB;	
		memory)) and (single semiconductor chip)) and (electrical	EPO; JPO;	
		signal\$1)) and (signal process\$3)) and (check\$3 and (data with	DERWENT;	
		error\$1 or reliability))) and (rewrit\$3 data and erased block\$1))	IBM_TDB	
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			DERWENT;	
			IBM_TDB	
21	10253808	microcomputer\$1 or (control device\$1)	USPAT;	2004/06/11 19:48
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			EPO; JPO;	
			DERWENT;	[
22		///////alashvisally avasies data was at black at the Later to the Late	IBM_TDB	2004/05/44 42 45
22	9	((((((((((((((((((((((((((((((((((((((	USPAT;	2004/06/11 19:48
		(electrically writing data near1 unit adj unit)) and (nonvolatile	US-PGPUB;	
		memory)) and (single semiconductor chip)) and (electrical	EPO; JPO;	
		signal\$1)) and (signal process\$3)) and (check\$3 and (data with	DERWENT;	
		error\$1 or reliability))) and (rewrit\$3 data and erased block\$1))	IBM_TDB	
		and (prescribed area)) and (microcomputer\$1 or (control device\$1))		
23	6467766	user data storage area	LICDAT.	2004/05/11 10:40
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			IBM_TDB	
24	9	((((((((((((((((((((((((((((((((((((((	USPAT;	2004/06/11 19:50
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		signal\$1)) and (signal process\$3)) and (check\$3 and (data with	DERWENT;	
		error\$1 or reliability))) and (rewrit\$3 data and erased block\$1))	IBM_TDB	
		and (prescribed area)) and (microcomputer\$1 or (control	12122	
		device\$1))) and (user data storage area)		